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The Imperial Strains of Lettuce

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INTRODUCTION

The Imperial strains of lettuce constitute an overwhelming proportion of the commercial crop in the United States. As a result there has been a constant and ever-increasing demand on the part of seedsmen, growers, plant breeders, and others connected with the industry for more information about these strains. The purpose of this circular is to bring together details of their development in order to meet this demand and to make the information readily available to all interested persons.

It is realized that some of the strains listed in this circular no longer make up a very large portion of the total acreage of the crop, but all of them have been important at some time and have been used, or are being used, in crosses from which it is hoped eventually to produce disease-resistant and better adapted strains. A total of 12 strains has been released since 1926. (See table 1.) However, this circular will be limited to a discussion of the varieties that are being grown commercially at the present time, together with the parent varieties from which they were developed.

[1] Deceased February 16, 1939.

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TABLE 1.—*The Imperial strains of lettuce, listed in order of their date of introduction*

Strain	Year introduced	Relative proportion of 1939–40 acreage of various strains
Imperial 2	1936	Discontinued.
Imperial 3	1926	Do.
Imperial 6	1928	Do.
Imperial C	1930	Do.
Imperial F	1930	Practically discontinued.
Imperial 13	1932	Small acreage (winter).
Imperial D	1932	Small acreage (late fall or early spring).
Imperial 152	1934	Small acreage (fall).
Imperial 615	1934	Large acreage.
Imperial 847	1936	Large summer acreage.
Imperial 44 [1]	1938	Eastern States.
Imperial 850	1939	Not tested sufficiently.

[1] Developed in cooperation with the New York (Cornell) Agricultural Experiment Station.

For the eight strains now being grown, the authors have attempted to give an adequate description of the mature head, the steps in development (pedigree), an illustration of typical mature heads, and miscellaneous information relating to maturity and adaptability of each strain.

There are good biological and commercial reasons for the development of a number of strains of head lettuce. The crisp-heading, so-called "Iceberg" types of lettuce are very sensitive to relatively slight differences in environmental conditions. Minor variations in temperature, nutrition, and moisture at critical periods may cause a particular strain to head well or poorly. Consequently, it is difficult, or even impossible, to produce a strain well adapted to a wide range of conditions.

Head lettuce is produced throughout the year and in many different localities. In order to produce good quality lettuce under fluctuating environmental conditions, it seems likely that a number of strains of the New York type will always be required. The poorly adapted strains will automatically be eliminated, and their place in the planting scheme will be taken over by the more adaptable ones. For each strain there is a set of optimum conditions under which it produces maximum yields of quality lettuce. It is obvious from the above remarks that some knowledge of the reaction of the various strains to a specific set of environmental factors is indispensable for successful lettuce culture.

There is an abundance of evidence to show that lettuce (*Lactuca sativa* L.) is a domesticated form of "wild lettuce" (*L. scariola* L.). Because of the distinctive arrangement of its component parts the lettuce flower is largely self-fertilized. For this reason once a strain or variety has become homozygous (pure) for its complement of characters, it is not difficult to maintain in uncontaminated form. A little care in separation of stocks in the field, in roguing, and in weed eradication should suffice to preserve a strain in comparatively pure form indefinitely.

According to Thompson,[2] cultivated lettuce can be divided into the following four types:

1. Crisp-head varieties such as New York (Wonderful) and Imperial strains.
2. Butter-head varieties, such as Big Boston and May King.

[2] THOMPSON, ROSS C. IMPROVEMENT OF SALAD CROPS. U. S. Dept. Agr. Yearbook 1937: 326–339, illus. 1937.

3. Loose-leaf or bunching varieties, such as Grand Rapids and Black-Seeded Simpson.
4. Cos or romaine varieties, such as Paris White Cos.

The Imperial strains are all of the crisp-headed type. It is true that some of them involve crosses with varieties outside this group, but the crisp-headed character has in each case been retained.

HISTORICAL

In the fall of 1922, in the Imperial Valley of California, the senior author began the investigation of a new, undescribed disease of lettuce, which is now generally known as brown blight. This disease causes a pronounced stunting and gradual death of afflicted plants. It is characterized by the appearance of small, yellow, discolored spots on the younger leaves and brown, dead, irregular blotching, and streaks on the older ones. The disease was soon found to be soil borne, with a rapid increase from year to year under continuous cropping with lettuce. There is evidence to indicate that it persists for several years even when soils are planted to nonsusceptible crops.

The cause of brown blight has never been determined, but there are reasons for suspecting that it may be a root parasite or a soil-borne mosaic disease similar to the soil-borne mosaic disease of wheat and other cereals.[3]

During the next few years brown blight appeared in most of the other lettuce-growing sections of California and Arizona. It threatened seriously to curtail lettuce production in these States, because much of the better lettuce soil was becoming too severely infested to produce lettuce. At present, so far as known, brown blight occurs only in California and Arizona, and lettuce is the only known host species.

The best method of coping with the disease appeared to be the development of resistant plants. As an initial step over 100 varieties and strains of lettuce were grown in small plots in a heavily infested field. These trials were repeated over 3 seasons. Two varieties, White Chavigne (Vilmorin No. 25357) and Big Boston, proved to be entirely immune to the disease. These varieties are not suited to culture in the West and Southwest. It was therefore necessary to cross them with the variety New York in order to combine desirable commercial qualities with resistance to brown blight. Several generations of selection resulted in the release to the industry of Imperial 13.

At the same time a more rapid method of obtaining brown-blight-resistant plants was investigated. Diseased fields were searched in the hope of finding plants of the variety New York that were resistant to brown blight. In 1924 a field was found in which there appeared to be a number of plants resistant to the disease. Progress was rapid, and selection within the progeny of these resistant plants resulted in the release to the industry of two resistant strains (Imperial 2 and Imperial 3) in 1926. (See table 1.) A third selection from the same source was distributed as Imperial 6.

The brown-blight-resistant strains mentioned above and the commercial variety New York are susceptible to lettuce mildew (*Bremia lactucae* Reg.). This disease causes considerable damage to the quality

[3] JAGGER, IVAN C. BROWN BLIGHT OF LETTUCE. Phytopathology 30: 53–64, illus. 1940.

of the crop. The infected plants are dwarfed and discolored, and if the heads are marketable the disease or saprophytic organisms that follow continue to develop in transit. As a result lettuce attacked by mildew is undesirable from a marketing standpoint.[4]

In 1922, crosses were made between a French variety (of the cos or romaine type) immune to mildew and the variety New York. By selection and backcrossing some very good mildew-resistant "New York" strains were obtained. These strains were crossed with the brown-blight-resistant strains Imperial 2, Imperial 3, and Imperial 6. Further selection resulted in the release to seedsmen of strains resistant to both mildew and brown blight. These include Imperial D, Imperial F, Imperial 615, and later Imperial 152, Imperial 847, and Imperial 850.

At the present time all of the strains of Imperial lettuce described in this report are brown blight resistant. Such is not the case with those formerly thought to be mildew-resistant. In 1932 in the Salinas Valley a new physiologic race of downy mildew (*Bremia lactucae*) appeared, as judged by the fact that all of the strains previously mildew resistant were susceptible. The present status of disease resistance in the Imperial strains described here may be summed up by stating that they are resistant to brown blight, but none of them are resistant to the new race of downy mildew.

ORIGIN OF THE IMPERIAL STRAINS

Before entering into a detailed description of the strains and an analysis of their pedigrees, it may be well to have in mind a picture of their origin and relation to each other. These relationships are presented in figure 1. Inspection shows that all of the Imperial

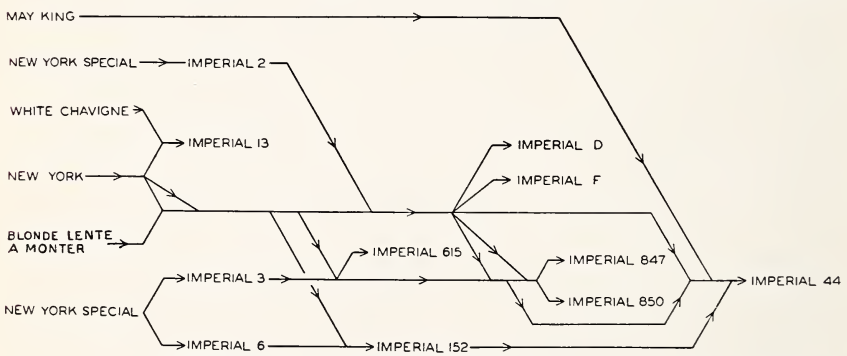

FIGURE 1.—Chart showing the origin and relationship of the Imperial strains of lettuce. The five varieties listed on the right were the parental stocks. Wherever the lines intersect a cross is indicated; a continuous line indicates selection and selfing. Imperial 2, Imperial 3, and Imperial 6 were derived from the same lot of New York Special.

strains stem from New York or New York Special; these were the original "Iceberg" types of lettuce. To obtain brown-blight resistance, selections were made within the variety New York Special, or the variety New York was crossed with the brown-blight-resist-

[4] JAGGER, I. C., and WHITAKER, T. W. THE INHERITANCE OF IMMUNITY TO MILDEW (BREMIA LACTUCAE) IN LETTUCE. Phytopathology 30:427–433. 1940.

ant variety White Chavigne (Blonde de Chavigne). It is also clear from this chart that Imperial 13 and Imperial 44 differ from other strains in that their pedigrees include White Chavigne and May King, respectively. This is not true of the others, which were developed by crossing, backcrossing, and selection from the varieties New York Special, New York, and a cos variety, Blonde Lente a Monter.

It is clear, therefore, that the Imperial strains of lettuce have descended either through hybridization or selection, or both, from the variety New York or New York Special (the latter is a somewhat less variable selection of the former). It is also evident from the chart (fig. 1) that in addition to New York and New York Special, three other varieties are involved in the origin of the Imperial strains, namely, a cos type, Blonde Lente a Monter, White Chavigne, and May King. As the source of parental stocks is of major interest to plant breeders, it has been thought wise to include a brief description and indicate the source of origin of these four varieties.

DESCRIPTION OF PARENTAL STOCKS

New York

Description.—A very large, crisp-heading type. The outer leaves are dark green and slightly curled along the margins. Mature heads are well exposed (fig. 2), the leaves fairly well folded, well

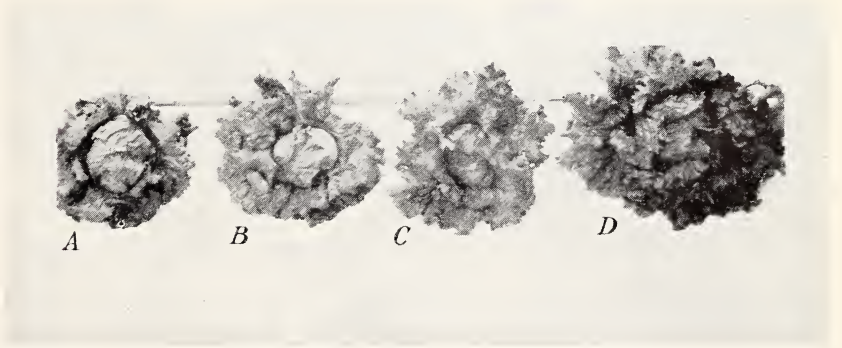

Figure 2.—Typical mature heads of New York (*A*), Imperial F (*B*), Imperial D (*C*), and Imperial 13 (*D*). Note the almost completely exposed head of New York, compared with the partially exposed head of Imperial F, and the well-covered heads of D and 13. The large size and abundant wrapper leaves of Imperial 13 are well illustrated in this picture.

bleached, crisp, and sweet. At maturity, typical heads are solid, of medium size, and of slightly flattened globe shape. This variety and strains selected from it have a tendency to be more or less variable, failing to make heads or at least loose fluffy ones. It characteristically has a high seedstalk, and most strains are susceptible to tipburn injury. For these reasons, and because it is not resistant to brown blight, the New York variety and strains of New York have been largely replaced by the less variable, more specialized Imperial strains. Seed of New York used in this work was obtained from commercial sources.

Blonde Lente A Monter (Vilmorin No. 27367)

Description.—A cos or romaine type. It does not form a head (fig. 3) and is light green in color; in other respects this variety is

Figure 3.—Typical plant of Blonde Lente a Monter. Note that the broad, spatulate-shaped leaves turn outward instead of forming a head.

similar to Paris White Cos. It was used in the development of the Imperial strains, because at one time it appeared to be immune to all known physiological races of downy mildew. This variety is sometimes referred to in this circular as "cos" in the interest of brevity.

White Chavigne or Blonde De Chavigne (Vilmorin No. 25357)

Description.—A butter-head type of medium size. It resembles Big Boston but is probably smaller. The leaves are a shade darker green and are smooth and thick, but lack the characteristic margin of red pigment that occurs in Big Boston. Resistant to brown blight. This variety is hereafter referred to in this circular as White Chavigne, the English equivalent of the French name.

May King

Description.—A butter-head type. It forms a medium to small compact head. The leaves are light green, with a brownish tinge around the margins. Seed of this variety was obtained from a commercial seed house.

DESCRIPTION AND PEDIGREES OF THE IMPERIAL STRAINS

Imperial F

Description.—Very similar to New York Special in all respects except that it is resistant to brown blight. It forms firm, round, more or less exposed heads of about New York size (fig. 4 and fig. 2, *B*). The heads are usually well folded, until near the middle or center, where some short leaves or "bunching" are found. The quality is excellent but probably not as good as Imperial D. Some types of F

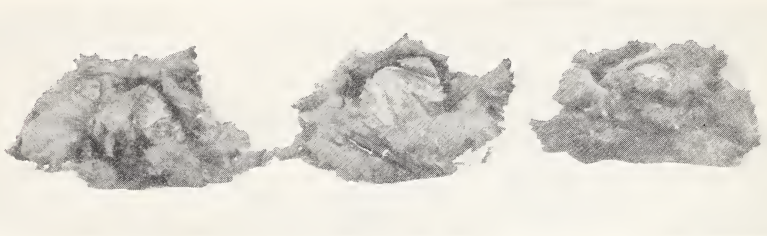

Figure 4.—Typical mature heads of Imperial F, they are well exposed and resemble those of New York in size and shape.

have a very thin paperlike leaf, whereas others have a thick, crisp-textured leaf. At present the acreage planted to this strain is very small, as it has been very largely superseded by better adapted varieties.

Pedigree.—The original cross was made in 1922, and the seed was distributed in 1930.

New York × Blonde Lente a Monter — 112–P (selected plant of New York Special)
↓
New York × A10A (selected F_2 plant) — Imperial 2 (increase [5])

F_1 × Imperial 2
↓
Selfed and reselected for 4 generations
Mass increase released as
↓
Imperial F

Imperial 13

Description.—A large, extremely high quality Iceberg type of head lettuce; heads are very hard and compact with unusually uniform fold and arrangement of leaves. (See fig. 2, *D*.) Mature heads are well bleached to the very outside, with a pleasing light-yellow color. The strain forms a very deep, heavy head, with an excellent spiral cover. The edible leaves are tender, crisp, and have an exceptionally mild sweet flavor. It is specifically adapted for harvesting in the

[5] "Increase" is the term used in the pedigrees to indicate that the progeny of the plant or plants on the line immediately above was grown in quantity and lumped together, either for distribution or to be exposed to further selection.

Imperial Valley from January 10 to February 20. During this period it can be relied on to produce a large percentage of high quality 4-dozen-to-the-crate heads. However, Imperial 13 has the objectionable characteristic of maturing all the heads of a particular planting at about the same time, and in warm winters it does not head uniformly. For these reasons the acreage of this strain has been very much restricted during the past 2 or 3 years.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1932.

New York × White Chavigne
↓
Selfed and reselected for 5 generations
↓
2065–Mass (increase)
↓
13–17 (selected plant)
↓
13–17–Mass (increase)
↓
120–Mass (increase)
↓
478–Mass increase released as
↓
Imperial 13

IMPERIAL D

DESCRIPTION.—One of the best of the Imperial strains from the standpoint of the consumer. It has a thick, crisp leaf, with a sweet rich flavor. The heads are well shaped, very hard, well folded, and usually a little larger than New York Special or Imperial F (fig. 5 and fig. 2, *c*). The outer dark-green leaves do not fade under unfavorable conditions, and the interior leaves are well bleached. It should be grown for harvest during the cooler season, as it is more subject to tipburn and to other warm-weather diseases than most of the Imperial strains. In addition, if grown in the warm season it has a tendency to make large sizes and produce numerous side shoots or suckers.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1932.

New York × Blonde Lente a Monter — 112–P (selected plant of New York Special)
↓
New York × A10A (selected F_2 plant) — Imperial 2 (increase)

F_1 × Imperial 2
↓
Selfed and reselected for 6 generations
↓
1029–9–Mass (increase)
↓
134–Mass increase released as
↓
Imperial D

FIGURE 5.—Typical mature heads of Imperial D.

IMPERIAL 152

DESCRIPTION.—Imperial 152 is similar to Imperial F and New York in size but matures earlier than either. It forms round, slightly flattened heads, partially exposed at maturity (fig. 6). The fold, bleach, and solidity of typical heads are excellent. The plants are probably lighter green than other Imperial strains at maturity. This is a specialized variety used for first plantings in the fall for Imperial Valley, Salinas Valley, and Arizona. It is not suitable for other plantings or other sections, because it tipburns readily and the sizes are too small for winter lettuce.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1934.

New York × Blonde Lente a Monter

↓

A107 (selected F_2 plant) × No. 69 (selected plant of New York)

↓

A107 × N. Y.–69–4 (selected F_2 plant)

↓

347–7 (selected F_3 plant)

↓

347–7–3 (selected F_4 plant) × Imperial 6

↓

(347–7–3 × Imperial 6)–1 (selected F_1 plant)

↓

Selfed and reselected for 2 generations

↓

Mass increase released as

↓

Imperial 152

No. 7 (selected plant of New York Special)

↓

7–3 (selected plant from above)

↓

7–3–Mass (increase)

↓

Imperial 6 (increase)

↓

FIGURE 6.—Typical mature heads of Imperial 152. The heads are partially exposed, but there are many wrapper leaves. The seedstalk is very low.

IMPERIAL 615

DESCRIPTION.—The heads of Imperial 615 are semiexposed, slightly flattened at the apex, and well folded at maturity. It makes a rather large spreading plant with an abundance of wrapper leaves (fig. 7). With the exception of Imperial 13 it is the largest of the Imperial strains (see fig. 8, *B*). At the present time it is more widely planted than other strains. Although primarily a cool-weather lettuce, it seems adapted to a wider range of conditions than any other strain and occasionally makes excellent crops of summer lettuce. However, if matured in warm weather, the heads have a tendency to bolt early and become large and coarse. Furthermore, the leaves frequently tipburn to a considerable extent in warm weather.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1934.

New York × laitue Blonde Lente a Monter

New York × A10A (selected F_2 plant)

113–20–P (selected plant of New York Special)

↓

Imperial 3 (increase)

F_1 × Imperial 3

↓

Selfed and reselected for 3 generations

↓

1431–Mass (increase)

↓

35–Mass (increase)

↓

389–Mass increase released as

↓

Imperial 615

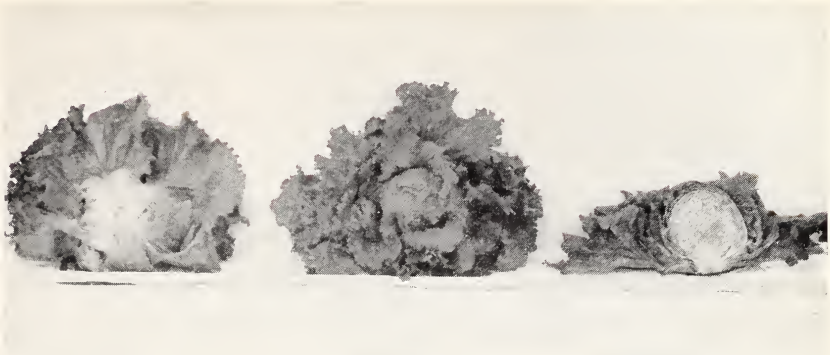

FIGURE 7.—Imperial 615; mature heads; note the well-covered head with an abundance of ground and wrapper leaves.

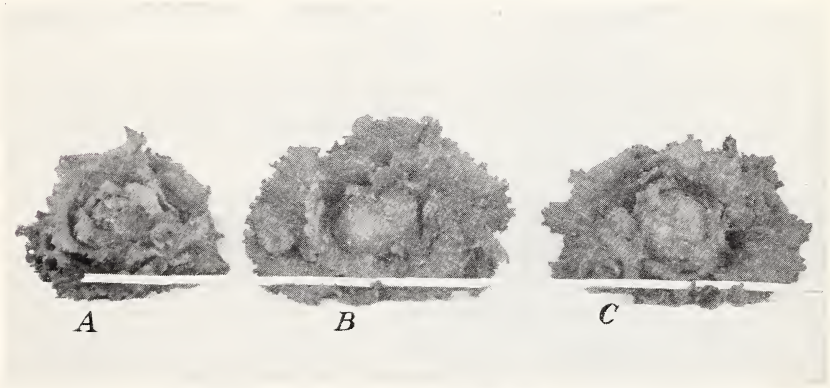

FIGURE 8.—Typical mature heads of Imperial 44 (*A*), Imperial 615 (*B*), and Imperial 847 (*C*). Note the small size of Imperial 44. It is obvious from this illustration that Imperial 615 is somewhat larger than Imperial 847.

IMPERIAL 847

DESCRIPTION.—Heads are round, well folded, of good quality, and partially exposed to bald at maturity (figs. 8, *C*, and 9). However, there are abundant wrapper and ground leaves. A large type, with a distinctive leaf, it is similar to Imperial F in a number of characteristics but is much more tolerant of warm weather. It is recommended primarily for summer harvesting; however, it is rather slow to mature and may require from 1 week to 10 days longer than Imperial F. In comparative trials with Imperial 152 this strain has proved to be about the same size but matures slightly earlier. Low temperatures during early maturity are likely to result in small sizes and uneven heading.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1936.

New York × Blonde Lente a Monter

A10A (selected F_2 plant, × AA (selected plant of New York)

F_1 × Imperial 2

H 4–4 (selected F_1 plant)

Selfed and reselected for 2 generations and mass increased twice

New York × Blonde Lente a Monter

A10A (selected F_2 plant) × B (selected plant of New York)

F_1 × Imperial 3

Selfed and reselected for 3 generations

Selfed and reselected for 2 generations

71–6–4 (selected F_4 plant) × 342–1–1–4 (selected F_4 plant)

5018–1–2 (selected F_1 plant)

8–4 (selected plant) × 2601–3 (selected F_2 plant)

(8–4 × 2601–3)–2 (selected F_1 plant)

2320–2 (selected F_2 plant)

1264–Mass (increase)

1264–M–4 (selected plant from above)

4550–3 selected plant increased and released as

Imperial 847

FIGURE 9.—Typical mature heads of Imperial 847.

IMPERIAL 44

DESCRIPTION.—Produces hard, well-formed, well-wrapped heads, with large well-folded leaves (figs. 8, *A*, and 10). Under California conditions Imperial 44 is smaller than 152; however, in warm weather it heads better and is less subject to tipburn than the latter strain. This strain seems to be well adapted for producing good summer

FIGURE 10.—Mature heads of Imperial 44. The heads are well covered, nonribbed, with very short seedstalks.

lettuce under certain eastern conditions, particularly on the muck soils of New York. In such an environment the heads are fully as large as 152.

PEDIGREE.—The original cross was made in 1922, and the seed was distributed in 1938.

New York × Blonde Lente a Monter
↓
New York × A10A (selected F_2 plant)
↓
F_1 × Imperial 2
↓
H 5–1 (selected F_1 plant)
↓
H 5–1–1 (selected F_2 plant)
↓
71–6–4 (selected F_3 plant) ×

New York × Blonde Lente a Monter
↓
A10A (selected F_2 plant) × B (selected plant of New York)
↓
F_1 × Imperial 3
↓
H 7–4 (selected F_1 plant)
↓
H 7–4–10 (selected F_2 plant)
↓
148–1–3 (selected F_3 plant)

F_1 × 342–6–3–4 (selected plant of May King)
↓
Selfed and reselected for 5 generations
↓
152–16 (selected plant of Imperial 152) × 530–5 (selected plant)
↓
Selfed and reselected for 3 generations
↓
6524–2 and 6524–5 (selected F_4 plants)
↓
8008MM and 8011MM increase released as
↓
Imperial 44

Imperial 850

Description.—Imperial 850 (fig. 11) is very close to Imperial 847 in all its characteristics, except that it has white seed and possibly is a little less subject to tipburn. Its close relationship with Imperial 847 is obvious from the pedigree. It is lighter green than 847 at maturity.

Figure 11.—Typical mature heads of Imperial 850. The heads are usually less exposed than Imperial 847; otherwise, these two strains are quite similar.

Pedigree.—The original cross was made in 1922, and the seed was distributed in 1939.

[6] 2320–3 (selected F_2 plant)
↓
1265–Mass (increase)
↓
1265–M–1 (selected plant from above)
↓
4551–4 (selected plant)
↓
4551–4–Mass increase released as
↓
Imperial 850

[6] The pedigree above this point is the same as Imperial 847.

SUMMARY

A summary of certain of the distinctive characteristics of each strain is presented in table 2.

TABLE 2.—*Comparison of the distinctive characteristics of the Imperial strains*

Strain	Seed color	Comparative size of head	Season of maturity [1]	Appearance at maturity	Days from planting to maturity (approximate)	Principal areas of culture
					Number	
F	White	Medium	Summer	Medium green	65–85	Salinas Valley, Calif.
13	do	Very large	Winter	Dark green	95–100	Imperial Valley, Calif.
D	do	Medium	Late fall	do	85–95	Salinas Valley, Calif.
152	do	do	Fall and late spring.	Light green	75–95	Imperial Valley and Salinas Valley, Calif., Salt River Valley, Ariz.
615	do	Large	Spring and winter	Medium green	95–150	Imperial Valley and Salinas Valley, Calif., Salt River Valley, Ariz.
847	Black	Medium	Fall and summer	Light green	65–85	Salinas Valley, Calif., Southeastern States.
44	White	Small	Summer	Medium green	56–80	Northeastern States, New York, and Florida.
850	do	Medium	Fall and summer	Light green	65–85	Delano district, California, Salinas Valley, Calif.

[1] In the localities where the varieties are now grown commercially.

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